solplan review

the independent newsletter of energy efficient building practice

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INSIDE....

Changes to the 1985 Edition of the National Building Code of Canada reflect some of the current concerns for indoor air quality. There are reservations about the adequacy of the new provisions. We review the new requirements and comment on some potential problem areas.

A series of standard market houses has been built using a variety of construction techniques and mechanical systems in Winnipeg. We describe the project and what is expected from this demonstration project.

Canada is a northern country. Our building techniques are designed for and applied in the more moderate climate zones. We review some of the design considerations needed for our more northerly locations.

A new graphical energy analyis tool has been developed that should be use in the design process. We offer a brief review.

Plywood can be used as a vapour barrier. We present a few observations.

Other items include the description of a new flueless natural gas fireplace unit; notes about a computer controlled R2000 house; and a review of the LEBCO symposium in Winnipeg.

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Richard Kadulski

INDOOR AIR QUALITY

FROM THE PUBLISHER

Our society is governed by a social contract: a set of laws, regulations and customs, written and unwritten, that we as a society have developed over time.

When there is a agreement about the overall objectives, the process works to everyone's benefit and the general state of humanity is improved. When there is a breakdown, when something goes wrong or someone ignores the basic consensus, the normal checks and balances break down and anarchy sets in.

The building code is a low level set of regulations designed to ensure the health and safety of the population. It is the code by which our housing is built safely. If the code does its job, there are no problems and it is generally respected. If it doesn't, the social contract won't collapse but there will be less respect for it. Evasion of its provisions become slightly more attractive and reasonable.

It is for this reason that we raise some areas of concern with the latest issue of the National Building Code of Canada. The drafting process is long and slow. Once implemented regulations are in effect for some time. There is adequate time and competent expertise in the country to evaluate the consequences of new requirements before implementation. It is why we would hope that the new ventilation requirements be reconsidered before the new edition of the National Building Code is implemented.

Richard Kadulski
Publisher

LETTER TO THE EDITOR

Sir,

(Re: Indoor Pool Design Considerations SR #9)

I would certainly not recommend a 60% relative humidity in any room containing a pool in this part of the country. If swimming pool room conditions are maintained at 80°F drybulb and 60% relative humidity, condensation will start forming on any surface that has a temperature below approximately 65°F.

In most areas of Canada, outside of the Vancouver area, wintertime temperatures fall to well below 0°F, and in fact, in many areas of Canada they go as low as -30° to -50°F. In very low temperatures we have found that it is not acceptable to keep relative humidity in most buildings at all above 20-30%. Condensation first becomes apparent on window frames, then on the glass itself and after that where the walls have reduced thermal resistance such as at concentration of framing members, etc.

If one is to maintain a swimming pool in an indoor enclosure in the cold climate areas of Canada it would be most advisable to maintain the room in which the swimming pool is located at a slightly negative pressure at all times so as to try to eliminate any possibility of having the moist room air leaking out into the building structure. In recent years I have had to investigate numerous swimming pools in the Edmonton area and have found very extensive damage in all types of buildings (concrete block, wood frame, metal, etc).

Donald E. Holte
Nova Engineering Ltd.
Edmonton, Alta.

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NATIONAL BUILDING CODE OF CANADA CHANGES AIRTIGHTNESS AND VENTILATION REQUIREMENTS

The 1985 edition of the National Building Code, the basic document used as building codes in most provinces, contains updated requirements for ventilation and air tightness in new home construction.

The new code comes into effect within the next year.

MEASURES TO PREVENT CONDENSATION

Studies of moisture problems resulting from condensation of water vapour in walls and ceiling/attic spaces show that the prevention of leakage of interior heated air into these spaces is more critical than reducing vapour diffusion.

In other words, a small hole in the wall is a much more important factor to moisture movement/condensation in the wall than the migration of moisture through wall materials.

The building code only refers to vapour barriers, although such an element will also act as a barrier against the movement of interior air into insulated wall or roof cavities. Service openings cut through this membrane for electrical boxes provide the opportunity for moist indoor air to leak into concealed spaces. Special measures must be taken to make then as airtight as possible.

Attention must also be paid to less obvious leakage paths such as holes for electrical or plumbing conduits, or wall/ceiling/floor intersections and gaps that may be created by shrinkage of framing members.

The code requires that

(9.26.5.1) vapour barriers shall be installed on the warm side of the insulation

(9.26.5.3) every vapour barrier shall be installed to protect the entire insulated wall surface, except that the vapour barrier need not extend across the framing members provided the interior finish consists of panel type material attached to all framing members with a continuous bead of adhesive in addition to the nails or staples required.

A new clause has now been added that if properly executed and enforced, will result in much tighter building envelopes:

(9.26.5.4). Insulation shall be protected by a vapour barrier installed so that all joints are sealed or are lapped at least 100 mm and occur at framing members, furring or blocking.

Also:

(9.26.5.7) Holes through vapour barriers, such as those cut for the installation of electrical wiring, electrical boxes, piping or ductwork, shall be sealed to maintain the integrity of the vapour barrier over the entire surface.

Every low energy builder (including all R2000 builders) will recognize that this is quite reasonable, and something that is being done now as a matter of principle in order to achieve the desired level of airtightness.

However, this is a requirement that will now be expected of all builders - whether or not they are fully aware of the impact of these new requirements.

How many builders are there out there of the old school that still talk about the need for a building to "breathe"? And who instictively argue against any form of tight construction practices?

In many cases these guys may have had a bad experience with a project that was built tightly (commonly an electrically heated house) but that did not have adequate ventilation, and hence ended up with moisture and condensation problems.

VENTILATION REQUIREMENTS

The committee drafting the current code revisions recognized that the tendency to build more airtight housing, may mean that natural ventilation is not enough to ensure acceptable air quality during the winter heating season.

As a result, the new code requires a mechanical system which will provide ventilation independently of natural sources, including windows and air infiltration.

(9.33.3.1) Dwelling units shall have a mechanical ventilation system capable of providing at least one half an air change per hour during the heating season, based on the interior finished volume of the dwelling unit. The system shall be controlled either manually by a switch or automatically.

(9.33.3.3) Mechanical ventilation systems for dwelling units shall include provision for introduction of fresh make-up air from the exterior.

In the past, the building code requirement for ventilation was assumed to be met by natural ventilation (i.e. opening windows) and natural infiltration. The code spelled out minimum opening window areas, and that was it.

One will note that a centralized ventilation system with ductwork leading to all parts of the house is not required by the new ventilation requirements. The code can be satisfied by means of exhaust fans located in kitchen or bathroom areas, while a fresh air inlet may be provided at a location remote from the exhaust outlet. However, a ventilation system operating in conjuction with a central heating or cooling system will meet the ventilation requirements.

The new ventilation requirements of the code don't deal with ventilation concerns in an adequate manner. Ventilation is called for, but nothing about heat recovery, nor, more importantly, the need for a carefully thought out make up air strategy.

If you exhaust air from one location, you must allow some air to enter at another location. Elementary physics.

Houses with combustion appliances, such as furnaces, will generally have some form of combustion air supply, so that exhausting air will be replaced. However, in electrically heated houses, there is no make up air. Electrically heated houses have had problems for some time because of the lack of adequate fresh air ventilation.

What will happen with a greater emphasis on tight construction without the requirement for some form of balanced ventilation system?

Another major shortcoming in the present wording is a lack of a clearly stated definitions. R2000 builders will recognize that the current R2000 Program technical standards call for half an air change per hour - based on total heated volume of the house (this includes unfinished basements and crawl spaces). Proposals for new ventilation standards suggest these will be reduced, partly because of evidence that current requirements may be too high. In some cases we may be over-ventilating our houses.

The way the new code is worded, it would seem that only finished floor area will be used to calculate the volume - thus eliminating unfinished basement areas so that the overall volume may be less than for R2000 calculations.

Nor does the code outline any guidelines for compliance with the code. How is the capacity of a fam or ventilator determined? Does one use a fan's face plate rating or actual installed capacity?

HEATING APPLIANCES

On fuel burning appliances, the code now states:

(9.34.2.3) Solid fuel burning appliances shall be installed in a manner that ensures the complete venting of the products of combustion to the outside air. Compensation shall be made for air drawn by other appliances or exhaust equipment

There is no other explicit comment or requirement for a combustion air supply. Other standards and codes apply to gas and oil burning furnaces, so that adequate combustion air supply is covered by those codes.

However, there are no separate codes or standards that apply to many types of fireplaces (except for factory-built units). The new code does nothing to set any standards.

(9.22.1.4) fireplaces, including factory-built fireplaces, shall have a supply of combustion air in accordance with (9.34.2.3)

but:

(9.34.2.3) Solid fuel-burning appliances shall be installed in a manner that ensures the complete venting of the products of combustion to the outside air. Compensation shall be made for air drawn by other appliances or exhaust equipment.

And that's it. No requirement for glass doors; no specific mention of the need for a direct source of combustion air to by-pass house air. At least the importance of balanced ventilation and the need to avoid the possibility of backdrafting is acknowledged.

Notes in an appendix to the code mention that the operation of air exhaust systems or of a fuel burning appliance removes the air from a house, creating a slight negative pressure inside. In some cases the natural flow of air up a chimney can be reversed, leading to dangerous backdrafting through fuel burning appliances, and the potential resultant carbon monoxide poisoning of the residents.

Newer houses are more tightly built, thus increasing the probability that natural infiltration will not be able to supply enough air to compensate for simultaneous operation of exhaust fans, fireplaces, clothesdryers, furnaces and space heaters. The current code revisions will lead to yet tighter houses!

Visible condensation on windows during cold periods shows that natural ventilation may not be enough.

The purpose of the building code is to set minimum criteria for the protection of public health and safety. The standards in the codes are meant to be minimums that can be exceeded.

Unfortunately, unless a customer makes a specific request, only competent professional builders exceed code minimums. Market pressures dictate that code minimums become the accepted maximum standards to which builders work. It appears that those involved with the writing and implementation of the code have lost sight of these realities.

A building is a system - the total is more than just a sum of its parts. While any one of the items may be optimum when incorporated as part of a building system the result may be different. It could be that the building community has not been taking a strong enough interest in the code writing and administrative process.

Hopefuly, ammendments will be introduced to overcome some of these shortcomings. Otherwise enforcement of the NBC may result in serious problems.

R-VALUE & RELATIVE HUMIDITY

The heat loss of glass determines safe levels of relative humidity that can be sustained by a building during cold weather.

The following table (data prepared by Trans Canada Glass) is a guide to the relative humidity levels which can be maintained inside a building before condensation will occur on glass.

OUTSIDE TEMP. °C	SINGLE GLASS	SINGLE GLASS & LOOSE STORM	DOUBLE GLAZED UNIT		TRIPLE GLAZED UNIT
			1/4" AIR SPACE	1/2" AIR SPACE	1/2" AIR SPACE
-30°	5%	23%	26%	32%	49%
-25°	8%	27%	30%	36%	53%
-20°	11%	32%	35%	41%	57%
-15°	15%	37%	40%	46%	61%
-10°	20%	43%	46%	52%	66%
-5°	27%	50%	53%	58%	71%
0°	36%	57%	60%	65%	76%
5°	47%	66%	69%	72%	82%

At normal room temperatures, most people will feel discomfort if the relative humidity level drops below 30%. Medical authorities indicate that it should never drop below 15%. The optimum comfort zone is 40-60%.

CORRECTION

In the last issue of SOLPLAN REVIEW the pressures of meeting printing deadlines meant that we made a significant error.

The item on indoor pools incorrectly stated that "increasing room temperatures will also reduce water evaporation". As can be deduced, it should have read that "increasing room temperatures will also increase water evaporation".

WINNIPEG LOW ENERGY HOUSE DEMONSTRATION

only the exterior elevations are modified, otherwise the houses have identical plans and orientations.

What is probably the most extensive demonstration and monitoring project in low energy energy house construction is now underway in Winnipeg.

20 houses built by Flair Homes Ltd. of Winnipeg are involved in the project, which is sponsored by Energy Mines Resources Canada with support from Manitoba Energy & Mines.

The project will demonstrate and evaluate the performance of a variety of wall-envelope construction techniques and various heat recovery ventilation systems for low energy houses. This project will provide actual performance data over the long and short term.

Comprehensive monitoring of the houses for a 4 year period (ending in 1989) is being done by UNIES Ltd. This is perhaps the most important aspect of the project. The monitoring will consider technical, economic and environmental considerations.

The monitoring program will include regular measurements of a number of variables including energy consumption, thermal performance (heat loss), and indoor air quality (formaldehyde, radon, carbon dioxide, nitrogen dioxide).

Structural durability will be assessed through airtightness tests performed several times per year along with regular survey readings checking for structural movement, wood moisture content and air tightness. Thermographic scans will be performed several times per year to locate cold spots (which may indicate leakage spots or moisture condensation).

The project has information transfer built into it. It is intented to make information available to builders as quickly as it is ready, to ensure that the building industry can benefit quickly from knowledge gained. (SOLPLAN REVIEW will be keeping in touch with the project to bring you results as they become available).

The houses are standard spec-built market housing. They have virtually identical floor plans (3 bedrooms, 1100 sq.ft. raised bungalow with a full basement). Although extra features built into the demonstration homes add about $7,500 to the cost of construction, the final price has been maintained at $80,000.

The project has two sections. 10 houses were built, sold and occupied during 1985. Of these, two were built to conventional standards to act as control houses, against which the performance of the other houses will be compared. The other houses were built using the Airtight Drywall Aproach (ADA).

Other envelope systems include double wall construction with poly air-vapour barrier, a single stud wall with rigid insulation sheathing, and a modified ADA system incorporating insulated sheathing with taped Tyvek skin air barrier.

The 10 houses built in 1986 have been paired to demonstrate five different building envelope and heat recovery systems. Table A summarizes the key features.

Mechanical systems include heat pumps which recover waste heat in exhaust air to warm domestic hot water plus provide space heating. These include the Peach air-air heat pump, the Nilan air-air heat pump, and the the Fiberglas Canada Habitair heat pump (SOLPLAN REVIEW #7).

Credit must be given to Flair Homes for their willingness to participate in the project and share the knowledge gained with other builders.

TABLE A: FLAIR HOMES ENERGY DEMO
SUMMARY OF DEMONSTRATION HOUSES: BUILDING ENVELOPE AND MECHANICAL SYSTEMS

	BUILDING ENVELOPE				MECHANICAL SYSTEMS				
HOUSE NO.	WALL CONSTRUCTION	AIR BARRIER TYPE	BASEMENT INSULATION	ATTIC INSULATION	SPACE HEATING	DHW HEATING	VENTILATION SYSTEM	VENTILATION DISTRIBUTION	ENVELOPE OPERATING PRESSURE
11	2x6 FRAME 2" GLASCLAD TAPED	FCI LEHS NO POLY LIMITED GASKETS	3" EXTERIOR BASECLAD 1½" GLASCLAD UNDERSLAB	FIBERGLASS	ELECTRIC BASEBOARDS FCI HEAT PUMP	FCI HEAT PUMP INT. WITH VENT SYSTEM	FCI EXHAUST HEAT PUMP INT WITH SPACE & DHW SYSTEM	ENVELOPE LEAKAGE & EXHAUST VENT. HEAT RECOVERY (C/W FRESH AIR DUCT)	SLIGHTLY NEGATIVE UNDERSLAB VENT
12	2x6 FRAME 2" GLASCLAD TAPED	FCI LEHS NO POLY LIMITED GASKETS	3" EXTERIOR BASECLAD 1½" GLASCLAD UNDERSLAB	FIBERGLASS	ELECTRIC BASEBOARDS FCI HEAT PUMP	FCI HEAT PUMP INT. WITH VENT SYSTEM	FCI EXHAUST HEAT PUMP INT WITH SPACE & DHW SYSTEM	ENVELOPE LEAKAGE & EXHAUST VENT. HEAT RECOVERY (C/W FRESH AIR DUCT)	SLIGHTLY NEGATIVE UNDERSLAB VENT
13	2x6 FRAME 2" GLASCLAD TAPED	FCI LEHS NO POLY LIMITED GASKETS	INTERIOR BATTS/FRAMING	FIBERGLASS	FORCED AIR ELECTRIC FURNACE	ELECTRIC TANK	VANEE HRV INTEGRATED WITH SPACE HEATING SYSTEM	ENVELOPE LEAKAGE & UNBALANCED HEAT RECOVERY VENTILATOR	SLIGHTLY NEGATIVE UNDERSLAB
14	2x6 FRAME 2" GLASCLAD TAPED	FCI LEHS NO POLY LIMITED GASKETS	INTERIOR BATTS/FRAMING	FIBERGLASS	FORCED AIR ELECTRIC FURNACE	ELECTRIC TANK	VANEE HRV INTEGRATED WITH SPACE HEATING SYSTEM	ENVELOPE LEAKAGE & UNBALANCED HEAT RECOVERY VENTILATOR	SLIGHTLY NEGATIVE UNDERSLAB VENT
15	DOUBLE WALL	6 MIL POLY	INTERIOR BATTS/FRAMING	CELLULOSE FIBRE	PEACH A/A HEAT PUMP INT WITH VENT & DHW SYSTEM	2 TANK SYSTEM INT WITH SPACE HEATING & VENT SYSTEM	PEACH A/A HEAT PUMP	COMBINED FORCED AIR HEATING & VENTILATION SYSTEM	BALANCED
16	DOUBLE WALL	6 MIL POLY	INTERIOR	CELLULOSE	PEACH A/A WITH VENT & DHW SYSTEM	2 TANK SYSTEM HEATING & VENT SYSTEM	PEACH A/A	COMBINED FORCED VENTILATION SYSTEM	BALANCED
17	DOUBLE WALL	6 MIL POLY	INTERIOR BATTS/FRAMING	CELLULOSE FIBRE	BASEBOARD HEATING	ELECTRIC TANK	NILAN A/A HEAT PUMP HRV & DUCT HEATER	INDEPENDENT HEAT RECOVERY VENTILATOR (C/W ADD SUPPLY AIR FAN	BALANCED
18	DOUBLE WALL	6 MIL POLY	INTERIOR BATTS/FRAMING	CELLULOSE FIBRE	BASEBOARD HEATING	ELECTRIC TANK	NILAN A/A HEAT PUMP HRV & DUCT HEATER	INDEPENDENT HEAT RECOVERY VENTILATOR (C/W ADD SUPPLY AIR FAN	BALANCED
19	2x4 FRAMING 2" SM	ADA WITH GASKETS	2" EXTERIOR SM & INTERIOR BATTS/FRAMING	CELLULOSE FIBRE	BASEBOARD HEATING	ELECTRIC TANK	VANEE HRV & DUCT HEATER	INDEPENDENT HEAT RECOVERY VENTILATOR	BALANCED
20	2x4 FRAMING KB SHEATHING 2" SM	ADA WITH GASKETS	2" EXTERIOR SM & INTERIOR BATTS/FRAMING	CELLULOSE FIBRE	BASEBOARD HEATING	ELECTRIC TANK	VANEE HRV & DUCT HEATER	INDEPENDENT HEAT RECOVERY VENTILATOR	BALANCED

LEGEND

INT.	INTEGRATED	PEACH	PEACH INTEGRATED HEATING/VENTILATION/DHW SYSTEM
C/W	COMPLETE WITH	NILAN	NILAN AIR TO AIR HEAT PUMP HRV DISTRIBUTED BY KEEPRITE
FCI LEHS	FIBERGLAS CANADA LOW ENERGY HOUSE SYSTEM	VANEE	VAN EE AIR TO AIR HRV
ADA	AIRTIGHT DRYWALL APPROACH	VENT	VENTILATION
SM	DOW CANADA EXTRUDED POLYSTYRENE	DHW	DOMESTIC HOT WATER
HRV	HEAT RECOVERY VENTILATOR	ADD	ADDITIONAL
A/A	AIR TO AIR		

ENERGY CONSIDERATIONS IN NORTHERN HOUSING

Many of the technical problems of energy efficiency in northern and southern housing are similar. However, the more severe conditions of the north, such as lower winter temperatures, lower relative humidities, and seasonally reduced solar radiation, may force the designer to look at new approaches.

In addition factors unique to the north such as permafrost, small isolated settlements (with difficult access and limited resources), and the dependence on oil require a different approach to construction.

The "North" includes all locations north of the southern limit of scattered discontinuous permafrost. The Canadian North is large geographicaly, and includes a larger population than one may think - with about 70,000 dwelling units. It includes some northern parts of the provinces as well as the Territories.

THE CLIMATE

An obvious factor in high energy consumption in the North is the climate. The severity can be seen by comparing the heating degree days (HDD) with southern communities.

COMMUNITY	HDD (°C)	DESIGN TEMP
WHITEHORSE	6878	-41°C
LABRADOR CITY	7770	-35
DAWSON	8272	-50
YELLOWKNIFE	8591	-43
FROBISHER BAY	9844	-40
INUVIK	10174	-47
VANCOUVER	3005	-7
TORONTO	4082	-18
OTTAWA	4674	-25
MONTREAL	4472	-23
WINDSOR	3590	-16
WINNIPEG	5887	-33

Contrary to expectations, available solar energy is surprisingly high. It can be utilized to reduce total annual energy consumption. During the winter there may be little, if any sun, but this is reversed during the long summer days. In the harsher climate there is a considerable demand for heat on a year round basis.

A passive solar strategy for the north would thus place emphasis on solar contributions during the spring and early summer months. This suggests the use of south facing glazing combined with relatively open floor plans and a mechanical heat distribution system.

Insulating shutters or blinds should be considered for fall and winter conditions of little or no solar radiation. Exterior insulating shutters, used on a seasonal basis may be appropriate.

Snow loads tend to be lighter than in many southern communities, but wind loads can be very severe.

ENERGY COSTS

Energy consumption and costs are higher in the North than in the south. In parts of the Eastern arctic, electricity costs as much as $0.55 per kwh! Wholesale heating oil prices can range $0.31-.77 per *litre*.

A recent study published by the National Research Council suggests that approximate total energy consumption in northern housing, adjusted to heating degree days per year, is comparable to that in southern housing. Unfortunately, after doing the comparison, the study admits that the comparisons were questionable as they did not compare size of houses, age, or types. In other words, they compared apples to oranges!

A recent survey of buildings in the Eastern arctic found that that average oil heating costs were $5825 per year, and a further $7200 for electricity. This survey included a number of commercial and institutional buildings as well as residences. The average building size was 2500 sq.ft. - the size of a house.

Energy consumption is high because housing stock has deteriorated over time, or was poorly built in the first place. Many buildings are designed without enough attention being paid to local conditions. Much of current housing stock operated by the Teritorial housing corporations was built with 2x4 walls (R13). It seems that this practice is only now begining to change.

BUILDING CODES

Building codes haven't addressed the need for regional variation.

Traditionaly, codes rely on the looseness of the building envelope and opening windows to provide the required fresh air for the occupants. With the trend to tighter construction, the National Building Code of Canada now requires mechanical ventilation to provide a minimum of one-half air changes per hour. (See story p3).

Mechanical ventilation in severe climates is important, as windows may be sealed shut during the winter. Sliding windows, often present in older houses, are frozen shut during the whole winter.

Calculations for air infiltration applied to supposedly "tight" buildings in severe northern conditions indicate high rates of air exchange. The combination of mechanical ventilation and natural infiltration during severe conditions may result in unexpectedly high rates of air exchange.

Mechanical ventilation strategies now becoming common are inappropriate to the North. Electrical costs to run an HRV can be exhorbitant. Current ventilation rates called for by the R2000 program, would cool a house in the North. Simple exhaust fans often don't work - but are a channel for air and snow leakage into the house.

Combustion air intakes are sized for the south. In practice, they are generally far too large in harsher climates.

Snow often drifts up against the building. The code insists that doors open outwards, yet snowdrifts may make it impossible to open the door!

Another code related problem is attic ventilation. Codes require it. However, in many northern locations fine snow is driven into attic spaces where it will accumulate, creating problems and possible structural damage during spring thaw.

Because of the short summer, wet construction materials do not get the opportunity to dry out (as may be the case in a more moderate climate).

Window design requires special consideration. Most are designed for moderate climates. Very fine snow tends to blow into the smallest cracks. Weep holes in windows get clogged. Many portions of the arctic are a desert - they have very little precipitation. They are so dry that wood dries out to as little as 7% moisture content (kiln dried wood leaves the oven with 16% moisture). Joints in frames open up, creating gaps. This is why new materials, such as vinyl, are popular.

High transportation costs and limited local resources, materials and qualified manpower, means that building systems must be carefuly thought out. The best are simple fail-safe systems.

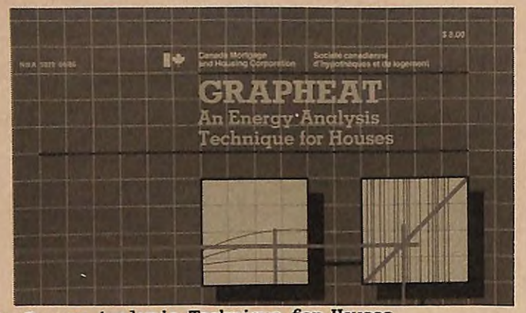
Construction to high standards is more expensive but the severe demands of the environment make it necessary for reasons of function and comfort. Quality is cost effective because of increased longevity and reduced operating cost.

Although it is possible to build high performance, durable housing, many buildings are still built to poor standards, which are inappropriate to local conditions.

A new publication from the National Research Council (Building Practice Note 55: Energy Considerations in the Design of Northern Housing) dicusses some of the practices applicable in the far North. This report discusses the severe climatic conditions, energy consumption, ventilation and air exchange issues in the context of current standards. Northern construction issues are outlined in terms of energy conservation, and typical heating and heat recovery equipment.

A Handbook of Northern Canadian Residential Building Practice is being prepared, and should be available soon from the National Research Council. This should help builders and designers, especially those from southern locations doing work in the north.

GRAPHEAT


Canada Mortgage and Housing Corporation
Société canadienne d'hypothèques et de logement
GRAPHEAT
An Energy-Analysis Technique for Houses

An Energy Analysis Technique for Houses

GRAPHEAT is a tool for use in the design of energy efficient housing that enables designers to estimate annual space-heating energy consumption and assess thermal comfort for detached, semi-detached or row houses.

The method assumes that the house is to be energy conserving (i.e. a well insulated relatively air-tight building envelope). GRAPHEAT enables the building designer to quickly assess the effect of many design changes on energy consumption and thermal comfort.

It cannot model earth-bermed buildings, slab-on-grade floor, sloped glazings, or any sunspace that is both unheated and an integral part of the internal space.

To use the tool, appropriate weather information is required, and data for 23 locations representative of most Canadian climatic regions are provided.

There are four parts to GRAPHEAT, in which the following are evaluated:

- the above grade heat loss coefficient;
- the maximum indoor temperature swing;
- the below grade heat loss;
- annual energy consumption.

A flow chart showing the overall approach is provided. It looks formidable, but only simple, easily available information about a building is required.

The information required is laid out in simple fill-in-the-blanks worksheets. The blanks are all numbered for easy cross reference where needed. It requires the use of metric measurements only. Anyone not currently using metric shouldn't find it difficult to use with a metric conversion calculator.

Is it easy to use? The authors caution first time users to read through the entire manual. The procedure is explained by working through an example to demonstrate the method. It takes an afternoon to read through to become familiar with the procedure.

2 BUILDING DATA SHEET 2

Windows

- Orientation: sketch the building on compass shown, and determine deviation from south for each set of windows.

				Ref. No.
- Ratio of clear glass area to rough window opening			0.8	17
- Clear glass for each orientation:	South Zone 18		Total	19
NOTE: the south zone consists of all those rooms that are subjected to significant amounts of sunlight in January.		southerly	15.6 m²	Building 15.6 m²
		easterly	— m²	— m²
		westerly	0.6 m²	0.6 m²
		northerly	7.9 m²	7.9 m²
Total clear glass area:			25.0 m²	20
- Glass type: SG, DG, TG, QG, or RSI value (Single, double, triple, quadruple glazed)			DG RSI	21
- Thermal shutter RSI value (0 if none)			0 RSI	22

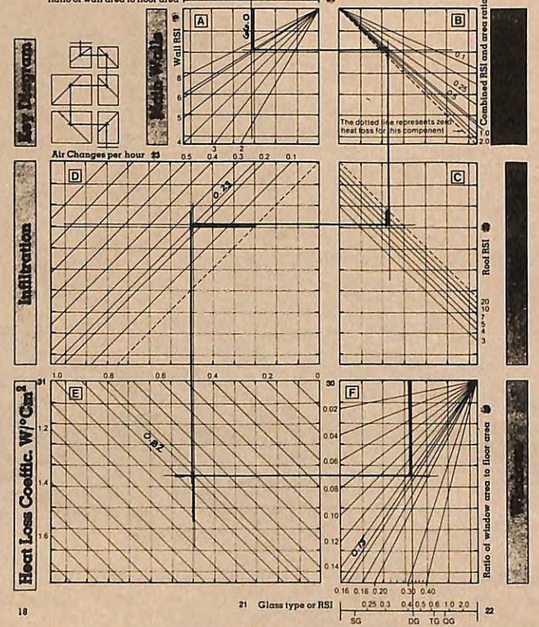
Infiltration

- Desired average ventilation rate (Natural and Mechanical)			0.5 ACPH	a
- Natural ventilation rate (infiltration)			0.16 ACPH	b
- Heat exchanger efficiency (0 if no heat exchanger)			.80	c
Effective cold air infiltration rate:	a	b c b		
	= (0.5 − 0.16) × (1 − .80) + 0.16 =		0.23 ACPH	23

Annual Energy Consumption

- Furnace seasonal efficiency Gas furnace: normal 0.65; spark ign.: 0.70; condensing: 0.95 Oil furnace: normal 0.65 Electric baseboard or furnace: 1.00	1.0		24
- Fuel energy content Electricity — 278 kwh/GJ Natural Gas — 27 m³/GJ Fuel Oil — 26 litre/GJ	27.8		25
- Fuel cost: $ per appropriate unit (kwh, m³, or litres) of fuel from local utility	0.040		26

4 ABOVE-GRADE HEAT LOSS NOMOGRAM 4



It's like a game of snakes and ladders: follow the path up & down around the chart to find the heat loss.

One tends to try and work through an excercise without reading the fine print (which is a mistake).

The manual is well laid out, and the example is done in a separate colour for easy reading. Blank worksheets are easy to photocopy (the manual is coil-bound).

We did spot one typographical error that will cause much confusion (and throw off the calculations): in the calculation of the effective cold air infiltration rate a plus (+) sign was used but it is meant to be a minus sign (-).

An important feature of this tool is that it enables the designer to estimate the solar-induced air temperature swing inside without getting into complex engineering calculations. The temperature swing is one of the key indicators of thermal comfort, and is of importance in the design of low energy and passive solar buildings.

Once one is familiar with the tool, it should be quick and relatively simple to use. It gives a visual and quantitative understanding of the issues involved. It offers a visual feel for the influence of the different elements in a building.

In this age of the computer, is a graphic tool needed? While everyone may now be using pocket calculators, not everyone has a computer. And some of the small personal computers do not have a wide range of software available to do all the calculations one may want. HOTCAN is not available for all computers on the market. GRAPHEAT was not designed to take the place of a computer simulation, but rather to offer something to those without a computer or not comfortable with them.

How accurate are the results? As with any predictive tool, the results are estimates and depend on the accuracy of the input data. Because this is a graphic method, drafting skill and accuracy are important.

Since this is a design tool, a number of assumptions may be made that will affect the accuracy of the numerical results. The difference in performance between designs is likely to more accurate than specific numerical values for the designs. The value of the tool is as a design aid to assess the impact of design changes.

GRAPHEAT was presented at the LEBCO symposium in Winnipeg.

GRAPHEAT is based on work by Okins, Leipciger, Cuplinkas, Kaminer and Assoc. for Canada Mortgage & Housing Corporation, and was redrafted by Building Engineering Group and Enermodal Engineering Ltd for CMHC.

CMHC Report no. NHA5878 (LHN5879 for the French version). Copies are available for $8.00 from:

CHMC Publications Office
Montreal Rd. Ottawa, Ont. K1A OP7

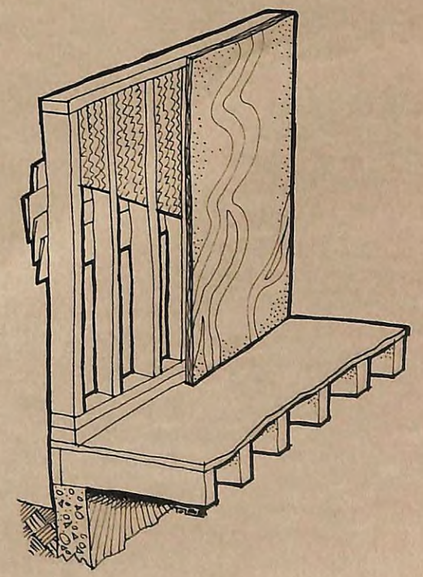
PLYWOOD VAPOUR BARRIERS

by Philip Daykin

The idea of using plywood as a structural air and vapour barrier is not new, but merits being considered as an option when circumstances warrant.

Reports of recurring or newly recognized problems with polyethylene indicate that the ultimate low energy construction details have not yet been developed. Perhaps the major cause of difficulty is that commonly there are <u>two</u> vapour barriers on the wall!

Plywood is recognized as a Type 2 vapour barrrier by the building code. When used as exterior sheathing the building code requires that a gap be left between sheets of plywood, waferboard or fibreboard. If it were to be installed with tight joints, (to take advantage of it as an air barrier), it would create a second vapour barrier on the outside. It is often necessary to cut holes in plywood sheathing or ensure that wall cavities are not sealed (as can easily happen beneath a window). If plywood can be used as a vapour barrier - isn't it in the wrong place when used as a sheating material?



To prevent moisture problems within the wall, the vapour barrier must be tightly installed and sealed on the warm side of the wall. This can be a difficult and costly task.

What would result if the plywood sheathing were to be installed on the inside of the wall frame? The intended racking resistance and air infiltration resistance would be the same as in the more conventional exterior location. However, the plywood could be put to use as a structural vapour barrier.

In 1973 the Mark VII house built in Surrey, B.C. by HUDAC (now the Canadian Homebuilders Association) used this technique.

An advantage is that a necessary structural component can also be used to provide a combined air and vapour barrier. Joints between sheets need to be against solid backing and must be caulked.

Electrical services, as is good practice in low energy housing, should be kept on the inside wherever possible. Where electrical services must be run through the outside walls, they must be boxed and caulked. If the design of the house permits, electrical rough-in on outside walls could even be done from the outside including sealing of the boxes and inspection and testing for leakage.

No doubt, openings for service outlets need to be more accurately sized than in current practice, and be boxed and caulked. The writer knows of one owner builder who did his wiring this way by choice.

Similarly, plumbing would best be located entirely interior to the plywood surface. If it need be on an outside wall, it could be furred on the interior, with removeable panels to facilitate repair work. With a compact bathroom, kitchem and utility room plan, only a small portion of the wall might need this furring.

Since racking resistance is provided by the interior sheathing, the outside of the frame wall requires only a cover that will exclude air, shed water and snow, allow water vapour to escape, and protect the structural frame and insulation from mechanical damage.

Tyvek is designed to serve the first three functions, siding materials can take care of the fourth.

Is exterior sheathing under the siding necessary? Most sidings do not need any more solid backing than is provided by framing and/or strapping. Stucco generally requires lath regardless of sheathing material.

Only by relocating a major building component, a rigid, smooth and almost indestructible interior surface is provided at no cost (actually at a negative cost if exterior sheathing is not used). The interior can be finished using any one of a wide choice of thin wall finish panels, installed with adhesive. Vinyl wallpaper, which is washable, may be the least costly but attractive and practical finish. For wallpaper, or thin veneer panelling, oriented strandboard, less costly than plywood and free of knot holes, would be more suitable.

Partition walls are simplified: the usual nailing support where the partition joins the outside wall may not be needed if the plywood can serve the same purpose.

If this description begins to sound familiar to our readers, it should be. What has been described, in essence, is known in another variation, as the airtight drywall approach.

The idea of plywood as the interior air vapour barrier has been used occasionaly in a number of houses for at least 10 years. It never was widely accepted because the building code did not recognize plywood as an acceptable vapour barrier material until very recently.

In recent years more use has been made of manufactured bracing straps which provide the necessary racking strength, thus doing away with the need for solid panel sheathing materials. The increased cost of plywood today, and the acceptability of the airtight drywall approach makes the plywood vapour barrier concept less attractive.

However, for those areas where plywood type materials must be used for structural reasons, this is a concept that should be considered.

Philip Daykin is a retired physicist, owner-builder and solar energy consultant living in Crawford Bay, B.C.

NEW PRODUCTS: VALOR FLUELESS FIREPLACE

VENTLESS SEALED COMBUSTION FIREPLACE

People continue to insist on a fireplace in their home, whether or not it is used. The fireplace is an aesthetic feature most homebuyers still want. Whether it makes any sense from a thermal point of view is of little concern.

In the last issue of SOLPLAN REVIEW we provided details for improving standard masonry fireplace design.

There are other alternatives. A new unit made in the United Kingdom and now being marketed in Canada is the Valor Homeflame gas fireplace.

Gas fireplaces by this manufacturer have been sold in Canada for the past few years. However, the units have been traditional chimney units, drawing some or all combustion air from the house. As a result there has been concern about backdrafting of gas and combustion products into the house when the house is placed under negative pressure as could happen if sevral exhaust fans are run at the same time.

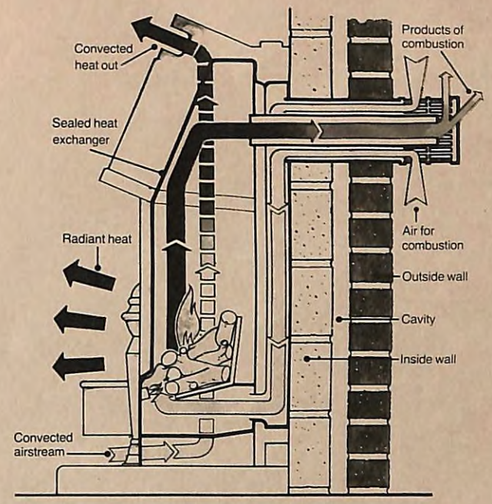
For space heating units directly coupled to the interior space do not qualify for the R2000 Program. To qualify as regular fireplace units they have to be fitted with combustion air kits (an optional extra).

To meet these requirements, the manufacturers have now developed a direct-vent, completely sealed combustion unit. Since the unit has a sealed combustion chamber, and it vents straight through the wall, it meets the requirements for the R2000 program, and can be used as the prime heat source.

The coaxial vent draws in air, mixes it with natural gas, and the combustion products are vented through the central duct back outside (without a chimney). The process cycles by a continuous, thermal cycle without a need for fans.

Flame ignition is by a piezo igniter, so there is no need for electricity or continous pilot light. As such, it can be operated during power outages.

The gas flame has several heat settings, plus variable flame controls, allowing the unit to operate with an output as low as 3500 BTU/hr. Maximum heat output is 13,650 BTU/hr. Properly located, the units should be able to provide all the heat required by a small dwelling unit.



Because the units are flue-less, heat losses due to stack-action are eliminated, and problems with flues through upper floor construction and roofs are eliminated. The major drawback is the severe limitation on design - the flue-less unit can only be installed against an outside wall (up to 16" thick), so a location on an interior wall is not possible, nor is it possible to locate a unit in a below grade basement or in a vaulted attic room.

The burners, firebox and secondary heat exchangers are made of stainless steel. The logs are permanent ceramic, the glass is temperature reistant. The finish on the unit is a baked epoxy on steel with brass trim, available in 3 designs.

Required clearance to combustibles is:
Back: 6"; sides: 6"; front: 36"; top to 6" wide mantle - 6"; ceiling: 36".

The unit has Canadian Gas Association approval. Its list price is $1295.

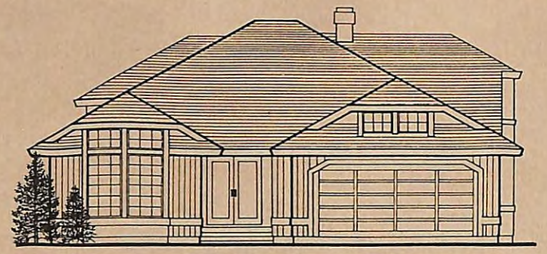
It may not be possible to roast wieners or marshmallows, nor will one hear the snap and crackle of a wood fire. However, it does provide the charm of a flame fire, heat (manufacturer claims it is up to 80% efficient), and it leaves no ashes or debris to clean up.

For the retrofitter, it offers the posibility to easily install a fireplace, without concern for venting or chimneys.

Canadian Distributor:

Miles Industries Ltd.
829 Third Street West
North Vancouver, B.C. V7P 3K7
tel: 604-984-3496

CANADA'S FIRST COMPUTER CONTROLLED R2000 HOUSE



Canada's first computer controlled R2000 home is under construction in Surrey, B.C. The house, being built by the Greater Vancouver Homebuilder's Association, will be the feature home in the *Homestyles 86* parade of homes promotion.

The house, a registered R2000 unit, is meant to be a showcase of currently available technology and quality construction demonstrating the skills of professional builders.

The 1765 sq.ft. 2½ bedroom home uses an energy efficient package, with Nascor exterior wall panels (R22); blown fireglass ceiling insulation (R40); and an insulated prefabricated preserved wood truss foundations for a heated crawl space (PWF foundations are not commonly used in southwestern B.C.).

Other products incorporated in the home include ESWA low temperature electric radiant ceiling heating; a conventional vanEE heat recovery ventilation system with computer controled vents to provide controlled air distribution as needed (e.g. more air to bedrooms at night, more to the living areas during the day); and a flue-less gas fired fireplace (see p 13).

Built as a smart house, the home's computer package will be capable of managing a number of household operations, including zone-controls for heating and vetilation to direct heat and fresh air where and when required, as well as monitoring energy consumption for efficient operation. If off-peak power rates were available, it would be able to maximize the benefits of such rates.

The computer will also have the ability to manage the household security system, control lights, appliances, fire and smoke alarms, operate garden sprinkler system, telephone answering service, and even provide a wake-up call service. Not all of these activities will be hooked up during the demonstration period, but the computer capacity will be there.

The house will be on the National R2000 Parade of Homes promotion. It will be open to the public from Sept. 19 to Oct. 9, 1986, after which it will be sold.

LEBCO NEWS

LEBCO SYMPOSIUM: June 22-25, 1985, Winnipeg

Indoor air quality and super windows were major topics discussed at the recent LEBCO symposium, held in conjunction with the annual conference of the Solar Energy Society of Canada in Winnipeg, Man.

The conference drew over 200 delegates from all parts of the country. Sessions of interest to low energy builders and designers were the best attended, indicating a significant level of interest.

SOME HIGHLIGHTS

Harold Orr reported on findings of moisture content monitoring in construction framing. Detailed studies of a number of highly insulated, double walled houses have shown that framing members had a moisture content of 9-11% on the north side of house, and less than 10% on the south side. The highest readings found in the Saskatchewan Conservation House were 11.5%. These are all well below the moisture content of kiln dried lumber which leaves the oven with a moisture content of 16%.

It has been found that moisture content in many low energy houses is well below the danger point. Evidently, if there is a problem, it is likely a result of improperly installed or damaged vapour barriers which allow moist warm air to enter the wall cavity and condense on colder outside surfaces inside the wall or roof cavity.

Ike Warkentin, a Manitoba energy consultant and builder provided his thoughts on low energy building based on his experience. He feels that zero energy houses are now technicaly feasible, but not yet cost effective.

He has noted that if batt insulation is used in ceilings, cold spots along rafter members can develop. Blown lose fill insulation is prefered as it will fill all voids if properly installed.

Ike prefers a single stud wall with rigid sheathing as it saves floor space. Property assessors base the value of a building on the gross floor area of the house (which includes the wall thickness). A thicker wall takes up floor space for which the owner ultimately pays. He calculates that on a basic 1300 sq.ft. house an exterior double wall takes 175 sq.ft. while a single wall with insulating board sheathing takes only 100 sq.ft. The net floor area gained by this saving offsets the incremental costs.

Another point he makes is that it does not pay to build with the idea of retrofitting later. (i.e. topping up attic insulation from an initial R40 to R60 later on). The costs involved with the later trip can't be justified.

Mark Riley from Energy Mines Resources Canada provided a brief update on the R2000 Program. He pointed to the move of the adminstrative process from the government to industry, and the continuing effort to reduce and simplify paperwork.

Changes in the technical criteria that will be introduced are a result of continued monitoring work on houses built to date. Major changes are being made to the HOTCAN program, which will reflect experience gained to date, and provide provide credits for specific mechanical equipment. The long awaited HOT2000 program is to be available "soon".

A result of the activity generated by the Program has been the development of new products and equipment as well as standards for residential equipment and systems, such as for polyethylene, wood stoves, ventilation, HRV's, airtightness, etc.

Product testing is continuing, with the objective of providing a measure of quality assurance for the homeowner.

A major concern of EMR is liability. (They don't want to see another UFFI disaster, so everything is being done in a very conservative way).

Greg Allen pointed out that improving housing has led to a more analytical approach to housing by the industry as a whole. He focused on the need to control indoor air quality. This can be done by attention to contaminant control: by controlling pollution at the source; by removing contaminants by dillution; and by filtration and treatment.

Greg illustrated his points by describing a house his firm designed and built for a family that had members with extreme chemical allergies.

When building an airtight house the builder must remember that construction materials themselves are contaminants. Dangerous off-gasing can come from all construction materials. For instance some concrete additives give off toxic fumes. Other materials, such as paints are volatile but off-gas quickly.

The objective is to control incoming fresh air (by filtering dust pollens, and other particulates); create a comfortable interior (removing drafts); avoiding cavity moisture (which can provide conditions for spore growth - the UFFI problem is not so much the UFFI itself but rather that it is a food for undesireable fungal growth).

Gary Proskiw, who is overseeing the monitoring of the Flair Homes demonstration project gave a brief introduction to the project. (see story p 6).

Gary pointed out that the project is breaking completely new ground. There are no established standards for evaluating the performance of building envelopes - rather they are doing the work by following basic engineering and physical principles.

Steve Carpenter reviewed computer studies of energy flows in houses to consider the importance of window orientation, optimum glass areas, the importance of interior thermal mass, off-peak power rates and mechanical systems.

A significant finding was the importance of window frames to heat loss: in many windows they can account for up to 28% of the nominal window area.

It was found that east and west windows get up to 70% of the solar radiation of south windows so interior heat gains through these orientations can be comparable to that on south side.

When potential overheating was considered, as could be expected it was found that the temperature swing increases with larger windows. With small windows, interior mass seems to have little effect. Double layer or gypsum board does not seem to be an effective way of adding thermal mass. Thermal mass is effective only for large windows, but they should be higher R-value units.

The speakers participated in a panel session with the audience. Most of the discussion focused on what the house of 1996 would look like.

There seemed to be a concensus that super windows will be an important feature, allowing more glass without energy penalties.

As the house becomes more efficient, there will be a move to a single energy source for the house. An all gas house would generate its own electricity! (It's not as far fetched as it may appear).

More stress will be placed on thermal comfort in larger, more efficient houses. With improved performance of appliances, a zero energy house may well be with us before too long.

New mechanical equipment, will be available, which will provide heating, cooling, ventilation, and domestic hot water in a sophisticated, easy to operate package.

Designers and builders will be more aware which holes in a building envelope are critical. There will be a fine tuning of trade practices.

Energy evaluation/labelling of housing will come out of the R2000 program. (similar to the mpg rating of automobiles).

COMING EVENTS

Innovations in Residential and Commercial Natural Gas Equipment & Systems: A one day seminar and product display on the newest trends in natural gas systems and equipment, for building trades and contractors.

Topics will include a review of new furnaces and boilers, how to choose the appropriate unit, the latest on new gas water heaters, gas fireplaces, do's and don'ts of venting the new equipment and information on choosing the most suitable equipment for low energy houses.

This seminar is organized by B.C. Hydro's Energy Management Division. Cost: $35.00 (includes lunch & seminar binder). 2 sessions: Sept. 23 and 24, 1986; Dogwood Room, PNE, Vancouver, B.C.

Preregistration advised. For information call George Pinch at 663-2317

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The Pursuit For Adequate Ventilation: Principles, Practices and Problems. This two day conference will focus on ventilation in the commercial and residential sector featuring John E. Janssen, Chairman of the ASHRAE Committee on Standard 62: Ventilation; Andrew Persily, National Bureau of Standards; Wiliam Fisk, Lawrence Berkeley Laboratories; and others.

November 13 & 14, 1986, Seattle, WA.

Information: call or write Susan Gregg, Washington Energy Extension Service, Seattle University, Seattle WA 98122 Tel: 206-626-6225

An Air Barrier for the Building Envelope

A one day session presented by the Institute for Reasearch in Construction of the National Research Council of Canada. It will feature 4 IRC scientists who will discuss the difference between a vapour barrier and an air barrier, air pressure loads within the building envelope, air leakage paths, and air permeability of materials. They will also present case studies of promissing new air barrier technologies.

These sessions will be presented in 12 Canadian cities: Moncton NB. Sept. 29; Halifax NS Oct 1; St. John's NF Oct 3; Toronto ON Oct 7,8,9; Edmonton AB Oct 22,23; Vancouver BC Oct 27; Regina SK Oct 29; Winnipeg MB Oct 31; Ottawa ON Nov 13; Quebec* PQ Nov 18; Rimouski* PQ Nov 20; Montreal* PQ Nov 25,26,27.

(*presented in French)

Advance registration $120.00; Students $60.00. For more information and registration, contact Madeleine Fleury 613-993-2607 or Gail LeBlanc 613-993-1231, Institute for Research in Construction (NRC, Ottawa)

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